

# EFFICIENT FLOW MEASUREMENT DEVICES FOR OPEN CHANNELS

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## ABSTRACT

The discharge flowing through open channel, can be measured by various devices which can be installed in the open channel. The guidelines and recommendations are needed for their use to the field staff, for choosing the precise type of device. Low discharge say less than  $40 \times 10^{-3} \text{m}^3/\text{s}$  can be suitably measured and comprehensive study can be done. Standing wave flume (SWF), 90-degree V- notch, Parshall flume and broad crested weir (Replogle) are chosen for comparison purpose, due to their common use in construction, ease in maintenance, afflux, location specificity and cost. Experiments are carried out in the open channel hydraulic lab. Broad crested weir (Replogle) of 20 cm sill height tops the list followed by 90-degree V- notch portable SWF and Parshallflume.

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**INTRODUCTION:** The measurement of discharge is utmost important in gravity system of irrigation for proper control and application of water. The devices situated at various locations starting from main canal up to the field channel. The study includes the flow measurement in small canals i.e. mainly water course or field channels. It is necessary to select simple water measurement device from the available ones. The preference is given to the following criterion fulfilled by the devices.

- (a) The device to be used should have simple design.
- (b) It should be accurate in flow measurement.
- (c) It should have less afflux formation on its u/s.
- (d) Its maintenance should be easy.
- (e) Facility of flow measurement from rating tables
- (f) It should be cheap.

## MEASURING DEVICES USED

The commonly devices used for measuring the flow under consideration are

### (a) Parshall flume -( 15 cm)

It is an accurate device and easy to design, but not so easy to construct as an exact shape and dimensions are necessary to attain. Frequent maintenance is required to retain dimension, causing afflux and cost is more. Due to this constraint Parshall flume is not recommended to use in field but it can be used in labs.

### (b) Standing wave flume (Throat width 20 cm with sill height 10 cm)

It is accurate, but construction is not simple. It can be fabricated by metal sheets and accurate dimensions can be maintained. For temporary measurement it is recommended.

### (c) A 90-degree V- notch

It is accurate, easy to design and construction, very cheap. As it requires clean over-fall and causes more afflux, not recommended for all locations. But if the conditions are favorable to V- notch are available and it can be recommended to use this device.

### (d) Broad crested weir (Replogle-sill height 20cm)

It almost satisfies all the criterion under field conditions. It scored the maximum points. It can be constructed in situ without much modifications for existing channel sections. Discharge table can be prepared using actual dimension after construction, even if there are variation in dimension during construction, easily repairable, its cost is less, causes less afflux relatively except at very low discharge. But it is sensitive to sill height and the side slope of channel. The discharge table can be easily prepared on computer; therefore, it is recommended to use in field on a large scale.

**METHODOLOGY:** The experimental study was carried out in the open channel hydraulics lab available in the institute. These measuring devices are tested for discharge variations of 10,15,20,25,30,35 and 40 lps. The losses from water surface during experimentation

were neglected as they are very negligible due to short period of time.

### Results and discussions:

**Table 1: Afflux ( $\Delta y$ -cm) for different devices under free flow conditions**

Sr. No	Name of Device	10lps		15lps		20lps		25lps		30lps		35 lps		40lps	
		Ha	R (12.6)	Ha	R (13.5)	Ha	R (18)	Ha	R (22.4)	Ha	R (21.9)	Ha	R (23.8)	Ha	R (25.2)
1	Parshall Flume (15cm)	10.8	7.9 63%	13.2	8.0 59%	15.8	8.3 46%	19.3	9.24 41.2%	21.2	9.0 41%	22.1	9.1 38.2%	25.2	9.5 38%
2	Standing Wave Flume	9.75	7.1 57%	12.4	7.3 54%	15.7	7.7 42%	19.3	8.8 39%	21.1	8.5 38.8%	22.2	9.4 39%	25.9	9.6 38%
3	90-degree V-notch	12.8	16.3 135.6%	14.8	8.8 88%	18.7	14.89 82%	19.7	14.85 68.3%	21.8	14.6 66%	21.5	14.7 61%	23.8	14.9 57%
4.	Broad Crested Weir	3.6	10.7 84.9%	4.1	9.7 71%	5.6	7.7 42.7%	6.3	7.78 34%	7.9	5.2 23.7%	8.1	4.7 19.7%	8.5	3.34 13%

**Table 2: Discharge Accuracy**

Sr. No	Name of Device	10lps		15lps		20lps		25lps		30lps		35 lps		40 lps		Average and Variation Absolute
		Dis	Vari	Dis	Vari	Dis	Vari	Dis	Vari	Dis	Vari	Dis	Vari.8)			
1	Parshall Flume (15cm)	9.9	1%	15.4	2.6%	20.2	1%	26.2	4.8%	32.84	9.4%	36.3	3.71%	41.2	3%	3.66
2	Standing Wave Flume	9.72	-2.8%	15.1	0.66%	19.24	-3.8%	24.8	-0.8%	29.4	2%	33.5	-4.2%	38.38	-4.0%	2.63
3	90-degree V-notch	9.78	-2.2%	15.18	1.2%	19.7	1.05%	26.2	4.8%	30.1	0.33%	34.3	-2%	39.5	-1.25%	1.83
4.	Broad Crested Weir	10.17	1.7%	15.2	1.33%	20.21	1.05%	24.81	-0.76%	30.31	1.03%	34.89	-0.31%	39.56	-1.1	0.51

**Table 3: Comparative Study of flow measuring devices**

Sr. No	Name of Device	Ease in	Ease in Construction	Use and Maintenance	Accuracy (10)	Afflux (10)	Cost (10)	Total out	Overall Ranking
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		Design (10)	(10)	(10)				(60)	
1	Parshall Flume (15cm)	6	3	5	5	4.8	4	27.8	4
2	Standing Wave Flume	7	6	6	6	4.2	6.4	35.6	3
3	90- degree V- notch	8	8	7	7	3.5	9	42.5	2
4.	Broad Crested Weir	8	8	6.5	9	8	8	47.5	1

**Conclusions and remarks:** Broad crest weir (Replogle) of 20 cm sill height constructed in situ is more suitable to measure small discharge under field conditions. If fall is available and afflux is no constraint, 90 degree -V- notch is recommended. Portable standing wave flume made of metal sheet with accurate dimension can be used to measure discharge temporary.

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